1698

LABORATORY EVALUATION OF THE PLASTIC VACUUM

PROBE SURFACE SAMPLER

F. H. Farmer
NASA Langley Research Center
Hampton, Virginia

and

J. J. Tulis, L. A. Taylor, and V. A. Pace, Jr.
Employees of Becton, Dickinson and Company

Presented at the Tenth Annual Meeting American Association for Contamination Control

Washington, D.C.
May 24-26, 1971

LABORATORY EVALUATION OF THE PLASTIC VACUUM

PROBE SURFACE SAMPLER

F. H. Farmer
NASA Langley Research Center
Hampton, Virginia

and

J. J. Tulis, L. A. Taylor, and V. A. Pace, Jr.
Employees of Becton, Dickinson and Company

ABSTRACT

An improved vacuum probe surface sampler, a device utilized to obtain specimens of the particulate contamination on surfaces, has been developed and has undergone a number of microbiological tests to determine if its removal or recovery efficiencies or reproducibility had been affected by either material or design changes. These tests indicated that none of these characteristics were adversely affected and that certain other modifications may be advisable.

I - Introduction

The vacuum probe surface sampler is a device for obtaining samples of the particulate contamination on relatively flat surfaces. It utilizes the shock wave produced by the flow of air through a critical orifice to dislodge particulate matter from the surface. These particles are then entrained in the flowing airstream and captured by a membrane filter located inside of the probe cone. This sampler was originally developed by the Sandia Corporation in the mid-1960's for sampling clean room surfaces.[1,2] NASA and its contractors have utilized it for this purpose on a very limited basis for the last 3 to 4 years. During this period of time, a number of other potential uses became apparent, some in the space field and others in fields such as public

health and criminal investigation. It was felt that in order for this sampling technique to fully realize its potential, the sampler would have to be improved. So we endeavored to improve its ease of handling, simplify its design, improve its inherent contamination control, and make it mass producible to reduce the cost factor. At the same time we wanted to retain its excellent removal and recovery efficiencies and reproducibility.[3,4,5] This development work was done under NASA contract NAS1-9398 and resulted in the injection molded, potentially disposable, commercially sterilizable plastic vacuum probe surface sampler, the components of which can be seen in Figure 1.[6] This sampler is the embodiment of most of the improvements we had hoped to make. In particular, let us take the case of contamination control during sampler assembly and disassembly operations. Handling of the probe cone has been kept to a minimum and only one clean or sterile instrument, a pair of filter forceps, is required for these operations. First, a clean or sterile filter is placed in the probe head using the pair of filter forceps. This operation can be seen in Figure 2. The disposable probe cone is then partially removed from its clean or sterile bag and placed on the probe head, using the bag as a means of holding the cone without contaminating it. The probe is then inverted and the cone tip is placed flat on a surface, the bag still protecting the tip from contamination, and the head is pressed downward until a slight snapping sound indicates a firm connection. The probe is then ready to attach to vacuum and begin sampling. The assembled probe in a sampling orientation can be seen in Figure 3. The vacuum pump used for the first test series can be seen in the background.

After the completion of the sampling procedure, the cone can easily be removed from the head by gently tapping the back of the cone against a

contamination free surface. In the case of microbiological sampling, a sterile petri dish is often used. After the cone is released, it can be removed using the filter forceps and access to the filter can be accomplished. In the case of microbiological sampling, the cone, filter, and O-ring are usually placed in a sterile beaker for further assay.

One other improvement that deserves individual mention is the ability to mold the special tip design into the cone piece. This reduces the cost of the sampler, while retaining the option to snap on a special purpose tip if the need arises.

Although every effort was made to configure the plastic sampler to the original sampler dimensions, it was necessary to carry out some laboratory tests to determine if the removal or recovery efficiencies and/or their reproducibility was affected by the material and design changes. It was also necessary to determine if the change in tip material, from Teflon to polystyrene, would affect the smoothness of the movement of the probe over various surfaces. While these tests were of a microbiological nature, the results generally apply to most particulate contamination.

II - The Floor Tile Sampling Tests

The first tests performed utilized the natural contamination of a 9- by 9-inch floor tile as a test population. The tile squares were sampled once using a back and forth motion of the sampler and then again using an up and down pattern. Five tile squares were sampled per vacuum probe unit. Sampling time was approximately 3 minutes. Both the polystyrene and Teflon tips were used. Biological assay consisted of removing the filter, sonicating it in a rinse fluid, and then removing aliquots of the rinse fluid for plating. The results of these tests are shown in Table 1. The average values for the five

samples were comparable with, if somewhat less than, the previously determined values for the original vacuum probe.[6] It is theorized that the reduction in recovery seen with the polystyrene tip was due to electrostatic charges built up on the cone during the sampling operation. It was decided to assay the cone as well as the filter in future tests. Only a slight difference in sampling smoothness was noted between the polystyrene and Teflon tips on the tile surface.

III - Stainless-Steel Strip Sampling Tests

A second set of tests was performed utilizing the natural fallout contamination on 1- by 2-inch stainless-steel strips as a test population. Sampling was done in the same manner as the first test, but an additional coverage of the strip using the back and forth motion of the sampler was added to the procedure. One strip, having an approximate population of 250 mesophilic heterotrophs, was sampled per vacuum probe unit. Sampling time was approximately 20 seconds and only the polystyrene tips were used. Biological assay of the probe consisted of sonicating the cone, filter, and O-ring and then plating out aliquots of the rinse fluid. The number of organisms remaining on the strips after sampling was determined by a similar procedure. Two tests were performed utilizing this procedure, 27 strips/test. Also, 27 control strips were assayed to determine the initial population. The results of the first test are shown in Table 2. The mean of the 27 controls and the 27 samples were 262 and 228, respectively, giving an average recovery of 87%. The percent removal was calculated for each sample, with the mean of these values being approximately 99%. As can be seen in Table 3, the results of the second test were very close to those of the first test. The average recovery for the two tests was 89% and the average removal was 99%. These values are at least

as good, and perhaps even slightly better than those previously determined for the original vacuum probe under the same conditions.[4] A distinct friction problem was noted with the polystyrene tip against the stainless-steel surfaces used in this test. This phenomenon was not noticed in previous tests using the Teflon tipped original probe. This supports results obtained during a recent facility test program conducted by NASA when over 80 samples were taken from simulated spacecraft surfaces of anodized aluminum. These results indicate that the Teflon tip should be used with metal surfaces to avoid a surface friction caused chatter effect which tends to reduce the sampler efficiency.

IV - Improvements

Recent tests at the Langley Research Center have shown that a sprayed-on Teflon coating has the same effect as a Teflon tip and does not reduce removal or recovery efficiencies. It is felt that a coating sprayed on the molded polystyrene cone tip in place of a machined Teflon tip would considerably decrease the per unit cost of the disposable portion of the sampler.

V - Conclusions

1. The plastic vacuum probe surface sampler is as efficient as the original sampler, while adding the advantages of mass producibility, commercial sterilization, disposability, molded tip, and better contamination control.
2. A Teflon tip surface is needed when metal surfaces are to be sampled.

Acknowledgment

The authors wish to thank N. Peterson of the U.S. Public Health Service for his cooperation in the performance of the stainless-steel strip sampling tests.

References

1. Dugan, V. L., Whitfield, W. J., McDade, J. J., Beakley, J. W., and Oswalt, F. W.: A New Approach to the Microbiological Sampling of Surfaces, The Vacuum Probe Surface Sampler, Sandia Corp. Research Report No. SC-RR-67-114, Albuquerque, (1967).
2. Dugan, V. L.: Principles of Operation of the Vacuum Probe Microbiological Sampler, Sandia Corp. Research Report No. SC-RR-67-688, Albuquerque, (1967).
3. Whitfield, W. J., Beakley, J. R., Dugan, V. L., Hughes, L. W., Morris, M. E., and McDade, J. J.: Vacuum Probe: New Approach to Microbiological Sampling of Surfaces, Appl. Microbiology, 17(1):164-168 (January 1969).
4. Peterson, N. J., and Bond, W. W.: Microbiological Evaluation of the Vacuum Probe Surface Sampler, Appl. Microbiology, 18(6):1002-1006 (December 1969).
5. Whitfield, W. J., and Morris, M. E.: The Vacuum Probe Sampler, Contamination Control, 9(2):10-15 (February 1970).
6. Phillips, G. B., and Petrovick, M. L.: Testing and Fabrication of Plastic Vacuum Probe Samplers, NASA CR-111796, (1970).

TABLE I

Micro-organism recovery from normal floor contamination using the Plastic long nose cone sampler and the Sandia short nose cone sampler

Testing Unit[1/]	Micro-organisms Recovered Per Tile Square					Average Organism Recovery
	Tile #					
	1	2	3	4	5	Per Tile Square
B-D Probe Teflon tip	3400	1600	22600	3800	700	6420
B-D Probe Polystyrene tip	7800	900	6200	5200	3700	4760
Sandia Probe Teflon tip	600	3300	15600	2600	10600	6540

1/ The average vacuum force was 12 inches of Mercury for each test trial

TABLE II

STAINLESS STEEL STRIP TEST # 1

Control Strip No.	Total Micro-organisms Recovered from Control Strips	Sample Strip No.	Total Micro-organisms Recovered from Probe & Filter	Total Micro-organisms Remaining on Vacuumed Strip	% Removal
1	280	1	214	4	98.2
2	215	2	238	2	99.2
3	243	3	179	1	99.4
4	253	4	207	7	96.7
5	253	5	172	4	97.7
6	203	6	245	0	100.0
7	300	7	294	2	99.3
8	215	8	287	2	99.3
9	190	9	259	2	99.2
10	185	10	189	4	97.9
11	508	11	172	6	96.6
12	185	12	147	5	96.7
13	258	13	182	3	98.4
14	253	14	161	1	99.4
15	383	15	214	2	99.1
16	230	16	256	4	98.5
17	175	17	242	1	99.6
18	250	18	238	2	99.2
19	315	19	200	0	100.0
20	235	20	207	2	99.0
21	243	21	291	3	99.0
22	233	22	207	1	99.5
23	328	23	319	1	99.7
24	443	24	256	0	100.0
25	268	25	277	0	100.0
26	240	26	214	2	99.1
27	190	27	287	3	99.0
Mean	262		228		98.9

% Recovery = 87

TABLE III

STAINLESS STEEL STRIP TEST # 2

Control Strip No.	Total Micro-organisms Recovered from Control Strips	Sample Strip No.	Total Micro-organisms Recovered from Probe & Filter	Total Micro-organisms Recovered on Vacuumed Strip	% Removal
1	195	1	410	2	99.5
2	295	2	245	1	99.6
3	255	3	207	2	99.0
4	265	4	207	3	98.6
5	203	5	308	4	98.7
6	115	6	196	2	99.0
7	63	7	210	1	99.5
8	220	8	252	4	98.4
9	185	9	200	3	98.5
10	190	10	168	2	98.8
11	153	11	193	3	98.5
12	230	12	172	2	98.9
13	240	13	137	2	98.6
14	190	14	168	1	99.4
15	163	15	168	2	98.8
16	180	16	91	2	97.8
17	238	17	186	1	99.5
18	240	18	158	1	99.4
19	185	19	165	6	96.5
20	373	20	182	1	99.5
21	253	21	144	0	100.0
22	178	22	252	0	100.0
23	198	23	221	0	100.0
24	323	24	186	1	99.5
25	283	25	252	4	98.5
26	223	26	147	1	99.3
27	190	27	77	0	100.0
Mean	216		196		99.0

% Recovery = 91

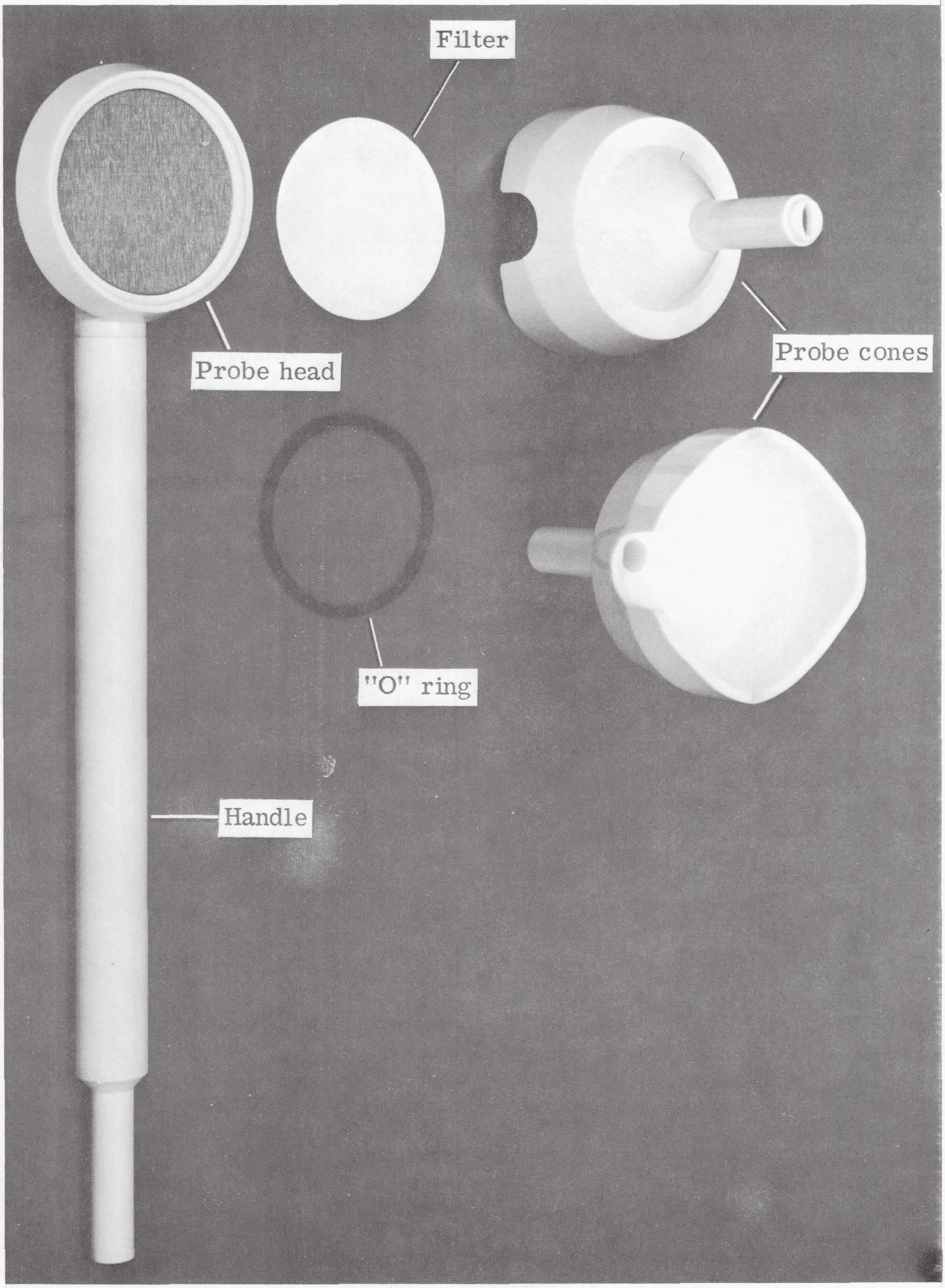

Figure I - Plastic Vacuum Probe Surface Sampler Components

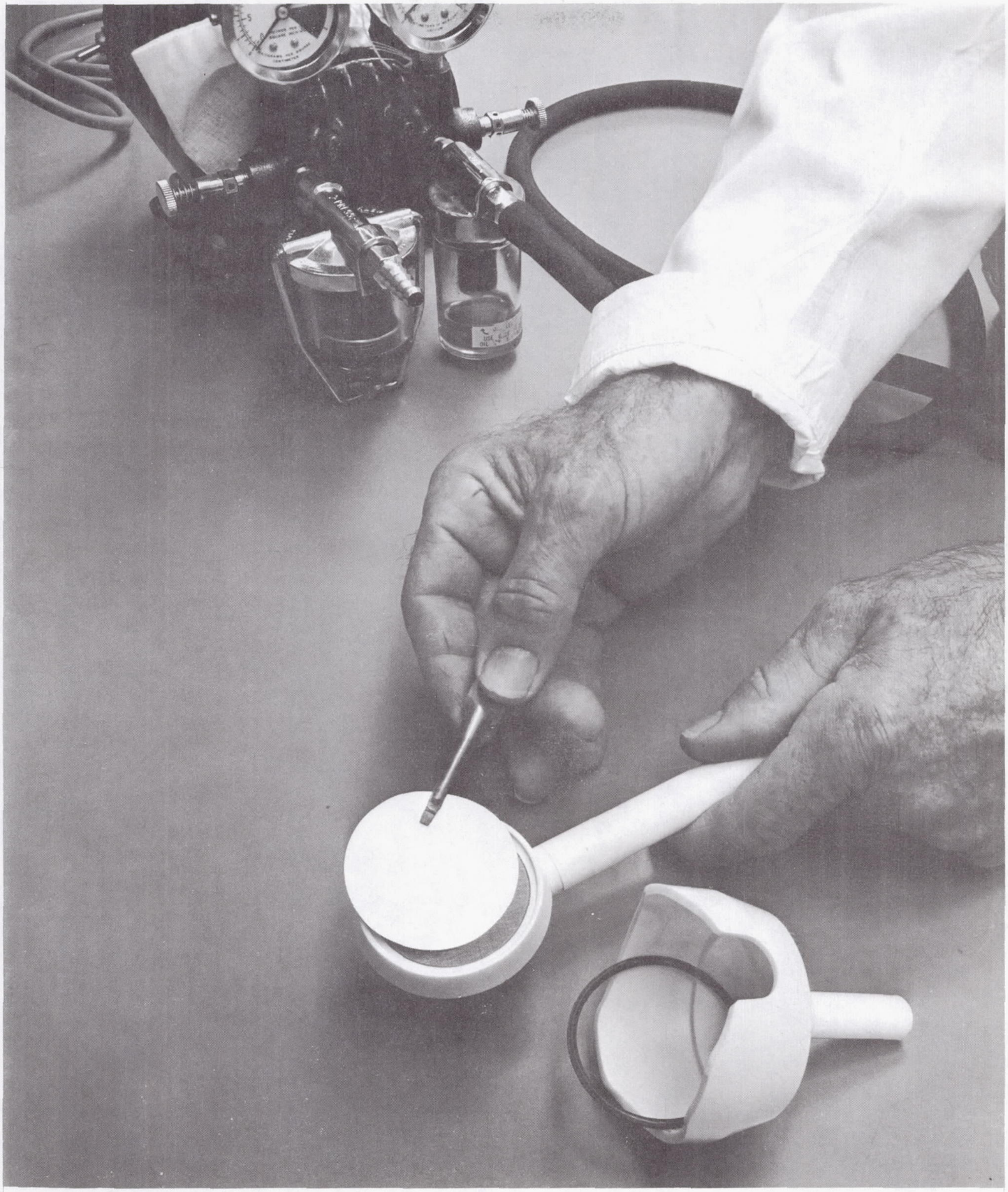

Figure 2 - Placement of the Filter in the Probe Head

Figure 3 - Assembled Sampler in Operating Orientation